HAWAII PRECIPITATION FREQUENCY STUDY

Update of *Technical Paper No. 43*

Third Progress Report
1 October 2001 through 31 December 2001

Hydrometeorological Design Studies Center
Hydrology Laboratory

Office of Hydrologic Development
U.S. National Weather Service
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DISCLAIMER

The data and information presented in this report should be considered as preliminary and are provided only to demonstrate current progress on the various technical tasks associated with this project. Values presented herein are NOT intended for any other use beyond the scope of this progress report. Anyone using any data or information presented in this report for any purpose other than for what it was intended does so at their own risk.

TABLE OF CONTENTS

1. Introduction 1

2. Highlights 3

3. Status 4

4. Progress in this Reporting Period 9

5. Issues 12

6. Projected Schedule 13

References 14

Appendix A 15

HAWAII
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Update of *Technical Paper No. 43*

1. Introduction.

The Hydrometeorological Design Studies Center (HDSC), Hydrology Laboratory, Office of Hydrologic Development, U.S. National Weather Service is updating its precipitation frequency estimates for Hawaii. Current precipitation frequency estimates for Hawaii are contained in *Technical Paper No. 43,* "Rainfall-Frequency Atlas of the Hawaiian Islands for Areas to 200 Square Miles, Durations to 24 Hours, and Return Periods from 1 to 100 Years" (U.S. Weather Bureau 1962). The update includes collecting data and performing quality control, compiling and formatting datasets for analyses, selecting applicable frequency distributions and fitting techniques, analyzing data, mapping and preparing reports and other documentation.

The study will determine annual and seasonal precipitation frequencies for durations from 5 minutes to 60 days, for return periods from 2 to 1000 years. The study will review and process all available rainfall data for the Hawaii study area and use accepted statistical methods. The study results will be published as a Volume of NOAA Atlas 14. They will also be made available on the internet using web pages with the ability to download digital files.

The study area covers the Hawaiian islands including Hawaii, Maui, Lanai, Molokai, Oahu, and Kauai. The study area including preliminary regions is shown in Figure 1.

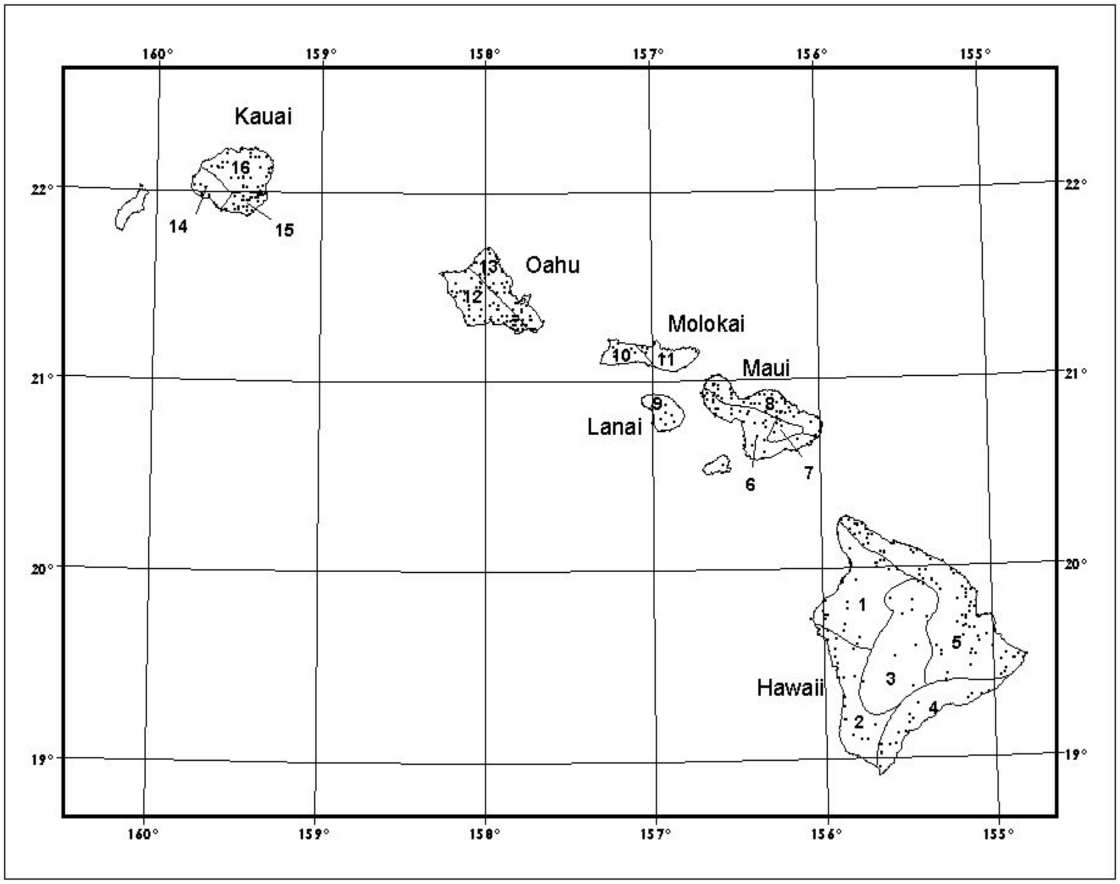

Figure 1. Hawaii Precipitation Frequency study area, regional divisions and daily station locations.

2. Highlights.

A clear agreement has been established between HDSC and the other funding agencies to wait for the University of Hawaii to manually digitize archived daily rainfall data from a network of state maintained gauges before proceeding with the HDSC study. Additional information is provided in Section 4.1, Data Collection and Quality Control.

Decisions regarding statistical procedures were made based on the comments of the L-moment Applications Working Group. Annual maximum series will be used rather than partial duration series. The unbiased plotting-position estimators will be used in the return frequency computations. Software to calculate the confidence limits of the precipitation frequency estimates has been developed. Additional information is provided in Section 4.3, Statistical Review.

A proposed agreement was reached between HDSC and Spatial Climate Analysis Service (SCAS) at Oregon State University (OSU) to produce a series of grids for rainfall frequency estimation. The mapping procedure will follow the “Index Flood” approach as described by Hosking and Wallis in “Regional Frequency Analysis; An Approach Based on L-Moments”, 1997, to estimate rainfall frequencies. Additional information is provided in Section 4.4, Spatial Interpolation.

HDSC is participating in an effort to assemble funds to update the precipitation frequency atlases for the entire United States. The full national update will use a consistent technical approach to data preparation, frequency analysis and mapping, as well as a consistent and more user-oriented approach to publication. Additional information is provided in Section 5.1, Updating Precipitation Frequency Atlases for Entire Nation.

HDSC has agreed upon a major shift in the preparation of NOAA Atlas 14 (NA14). Depth-area-duration (DAD) values will be prepared and presented in a separate report. Additional information is provided in Section 5.2, Depth-Area-Duration Study.

The project schedule has been changed following a detailed examination of current status and to account for changes in technical approaches and the addition of new data. Details are in Section 6, Projected Schedule.

3. Status.

3.1 Project Task List.

The following checklist shows the components of each task and an estimate of the percentage completed per task. Past status reports should also be referenced for additional information. Due to technical review and procedural changes, the estimated percentages have been modified to match the current project schedule.

Hawaii study checklist [estimated percent complete]:

Data Collection, Formatting and Quality Control [25%]:

- Daily
- Hourly
- 15-minute
- N-minute

L-Moment Analysis/Frequency Distribution for 5 minute to 60 days and 2 to 1000 years [0%]:

- Daily
- Hourly
- 15-minute
- N-minute

Algorithm/Data Plot [10%]

- Establish regions from spatial, topographic and meteorological variables
- Run L-moments for regional growth factors to generate dataset
- Create grids of distributed means for each duration using PRISM (see Table 1)
- Subject grids of distributed means to external review
- Create smoothed regional growth factor (RGF) grids using GRASS: (5-1000) yr (1-12) hr, (5-1000) yr 24hr, (5-1000) yr (2-60) day

Table 1. Proposed List of Grids of Distributed Means.

Duration	Season
1-hr	all
1-hr	cool, warm
2-hr	all
3-hr	all
6-hr	all
6-hr	cool, warm
12-hr	all
24-hr	all
24-hr	cool, warm
48-hr	all
4-day	all
7-day	all
10-day	all
20-day	all
30-day	all
45-day	all
60-day	all
Total: 26 (14 all, 6 warm, 6 cool)	

Precipitation Frequency Maps [0%]

- Multiply appropriate RGF and grids of distributed means to produce precipitation frequency grids for durations and seasons shown in Tables 1 and 2
- Apply domain-wide conversion factor to the 1-hour precipitation frequency grids to calculate the n-minute (5-, 10-, 15-, and 30-minute) grids
- Perform internal consistency checks (comparing rasters of sequential duration and frequency)

Table 2. Proposed List of Precipitation Frequency Rasters.

Duration	**Frequency**	**Season**
5-min	2-yr, 5-yr, 10-yr, 25-yr, 50-yr, 100-yr	all
5-min	2-yr, 100-yr	cool, warm
10-min	2-yr, 5-yr, 10-yr, 25-yr, 50-yr, 100-yr	all
10-min	2-yr, 100-yr	cool, warm
15-min	2-yr, 5-yr, 10-yr, 25-yr, 50-yr, 100-yr	all
15-min	2-yr, 100-yr	cool, warm
30-min	2-yr, 5-yr, 10-yr, 25-yr, 50-yr, 100-yr	all
30-min	2-yr, 100-yr	cool, warm
1-hr	2-yr, 5-yr, 10-yr, 25-yr, 50-yr, 100-yr	all
1-hr	2-yr, 100-yr	cool, warm
2-hr	2-yr, 5-yr, 10-yr, 25-yr, 50-yr, 100-yr	all
3-hr	2-yr, 5-yr, 10-yr, 25-yr, 50-yr, 100-yr	all
6-hr	2-yr, 5-yr, 10-yr, 25-yr, 50-yr, 100-yr	all
6-hr	2-yr, 100-yr	cool, warm
12-hr	2-yr, 5-yr, 10-yr, 25-yr, 50-yr, 100-yr	all
24-hr	2-yr, 5-yr, 10-yr, 25-yr, 50-yr, 100-yr	all
24-hr	2-yr, 100-yr	cool, warm
48-hr	2-yr, 5-yr, 10-yr, 25-yr, 50-yr, 100-yr	all
4-day	2-yr, 5-yr, 10-yr, 25-yr, 50-yr, 100-yr	all
7-day	2-yr, 5-yr, 10-yr, 25-yr, 50-yr, 100-yr	all
10-day	2-yr, 5-yr, 10-yr, 25-yr, 50-yr, 100-yr	all
20-day	2-yr, 5-yr, 10-yr, 25-yr, 50-yr, 100-yr	all
30-day	2-yr, 5-yr, 10-yr, 25-yr, 50-yr, 100-yr	all
45-day	2-yr, 5-yr, 10-yr, 25-yr, 50-yr, 100-yr	all
60-day	2-yr, 5-yr, 10-yr, 25-yr, 50-yr, 100-yr	all

Data Trend Analysis [0%]

- Analyze linear trends in annual maxima and variance over time
- Analyze shift in means of annual maxima between two time periods (i.e., test the equality of 2 population distribution means)

Seasonal Analysis [0%]

- Create graphs of percentage of precipitation maxima in each month of a year

Temporal Distributions of Extreme Rainfall [0%]

- hourly data assembled by quartile of greatest precipitation amount and converted to cumulative rainfall amounts for each region
- graphs of representative storm-types and seasons

Deliverables [10%]

- Write hard copy of Final Report
- Prepare data for web delivery
- Prepare documentation for web delivery
- Publish hard copy of Final Report

Additional Work:

Spatial Relations (Depth-Area-Duration Study) [10%]

- Obtain data from dense-area reporting networks
- QC and format data from dense networks
- Compute maximum and average annual areal depth for each duration from stations from each network
- Compute ratio of maximum to average depth for all durations and networks and plot
- Draw curves of best fit (depth-area curves) for each duration and network

3.1.1 Data Collection and Quality Control.

The University of Hawaii will be digitizing daily data from a network of state operated gauges. Once this data is added to our dataset the number of daily stations will greatly increase. The University will enter monthly maximums of daily data. Data from the Big Island will be entered first and subsequently provided to the HDSC to begin final QC and processing. Data entry by the University will then concurrently continue westward up the island chain as the HDSC processes data from the Big Island.

The NCDC daily and hourly datasets have been updated through December 1999 and the n-minute dataset through May 1997. When we receive the completed digitized state dataset from the University of Hawaii we will update our database with all available NCDC data at that time.

3.1.2 Mapping Analyses.

Discussions with the Spatial Climate Analysis Service (SCAS) have determined that, with additional optimization, Parameter-elevation Regressions on Independent Slopes Model (PRISM) technology will be adapted to precipitation frequency data. SCAS will use PRISM technology to spatially interpolate distribution means. These grids will be subjected to external review and then HDSC will apply regionally computed L-moments to calculate the final precipitation frequency values.

3.1.3 Documentation and Publication.

The Hawaii study results will be available on the HDSC Precipitation Frequency Data Server once mapping is complete and reviewed. The Data Server displays precipitation frequency values and intensity-duration-frequency curves and tables.

A sophisticated cartographic map-making process has been designed using the latest release of ArcView software. A final cartographic-quality map template has been reviewed, revised, and completed. The map template will serve as the basis for all future precipitation frequency maps. The maps will be available both online (as ArcInfo ASCII raster, ArcView GIS shapefile, postscript and JPEG files) and in a hardcopy form with the final reports.

4. Progress in this Reporting Period.

4.1 Data Collection and Quality Control.

A clear agreement has been established between the HDSC, the Hawaii Department of Land and Natural Resources, the US Army Corps of Engineers and the University of Hawaii to wait for the University to manually digitize daily rainfall data from the paper archives of a network of state maintained rain gauges. This data will greatly enhance the spacial resolution of our dataset. By request of the funding agencies, the current plan is to digitize data from the Big Island of Hawaii first and produce preliminary precipitation frequency maps for the Island, then digitize data from the remaining islands. The University estimates that the data for the Big Island will be entered and made available to HDSC by the end of Spring 2002.

The funding agencies also agreed that because of budget and time constraints, along with the main requirement of this study being a 24 hour duration; the University will enter only monthly maximums of the daily data from the state database. This will be sufficient to determine an annual maximum series from the daily data. The agencies realize and accept that this will not provide Precipitation Frequency information for durations other than 24 hours at the state data locations. NCDC data will provide estimates for the other durations.

The HDSC has defined a well-developed and efficient set of procedures for data collection and quality control. The procedures have been refined over time for extracting and quality controlling data from the National Climatic Data Center. The procedures and data formats are structured to fit efficiently into sequential processes for producing updated rainfall frequency estimates. We plan to continue using these procedures. The HDSC plans to publish the final quality-controlled time series used in the analysis.

4.2 Mapping.

There is no recent rain gage data for the island of Niihau and only one gage on the island of Kahoolawe which is not sent to NCDC and has a short period of record. The funding agencies have suggested that if analyses are done for these islands, strong qualifiers should be placed on them since they would be based exclusively on model data from PRISM. Once all the data is available and the PRISM procedures are complete, HDSC will be able to make a better determination on whether to produce estimates for these two islands.

4.3 Statistical Review.

Decisions regarding statistical procedures were made based on the statistical procedures described in *Regional Frequency Analysis: An Approach Based on L-Moments*, Hosking and Wallis, 1997 and on the comments of the L-moment Applications Working Group (David Goldman, Ned Guttman, and John Hosking). Annual maximum series will be analyzed rather than partial durations series. However, we will analyze conversions to partial duration series so that both results can be presented for 2-year to 25-year return frequencies. The software for extracting the annual maximum series has been debugged and refined for n-minute, hourly and daily data. The criteria ensure that each year has a sufficient number of monthly maximums, particularly in the rainy season, to accurately extract a statistically meaningful annual maximum.

HDSC will use unbiased estimators in the estimation of L-moments and L-moment ratios. Also, software was developed to calculate the confidence limits of the precipitation frequency estimates. As suggested by Hosking and Wallis, the upper and lower bounds of a quantile estimate at 90% confidence level will be directly counted at the upper 5% point and the lower 5% point, respectively, from a series of simulated quantile estimates for each site via Monte Carlo simulation. The simulation number is set to 1000 and there is no need to assume a particular distribution to the quantile estimates before calculating their confidence bounds.

4.4 Spatial Interpolation.

A proposed agreement was reached between HDSC and Spatial Climate Analysis Service (SCAS) at Oregon State University (OSU) to perform spatial interpolation of rainfall frequency estimates for the Semiarid Southwest and Ohio River Basin study domains. This agreement will serve as a prototype for applying PRISM in the Hawaii study. Grids will be produced using an optimized system based on the Parameter-elevation Regressions on Independent Slopes Model (PRISM) and HDSC-calculated point estimates. SCAS will use PRISM technology to spatially interpolate distribution means. These grids will be subjected to external review and then HDSC will apply regionally computed L-moments to calculate the final precipitation frequency values. A substantial portion of the study is dedicated to optimizing PRISM, conducting a through review of selected maps and using a modified quality control (QC) version of PRISM to make a series of spatial QC tests. Additional details can be found in the proposed Statement of Work for the production of the grids (Appendix A).

The mapping procedure will follow the "Index Flood" approach as described by Hosking and Wallis in "Regional Frequency Analysis; An Approach Based on L-Moments", 1997, to estimate rainfall frequencies. In this approach, the mean of the underlying rainfall frequency distribution is estimated at point locations with a sufficient history of observations. This mean is referred to as the "Index Flood" because early applications of the method were to flood data. Using PRISM, the SCAS will create spatially interpolated grids of the point estimates of the Index Flood for each of the 14 durations. Once the form of the distribution and the other parameters of the distribution are estimated regionally, rainfall frequency estimates can be computed. HDSC will use the regional L-moment distribution parameters with the grids of distributed means to calculate the actual rainfall estimate grids.

Additionally, the master data files now reflect station locations to the nearest second. Previously, the location was stored only to the nearest minute. This modification was possible due to recent availability of higher resolution longitude and latitude coordinates for climate stations and to the advantage this provides when mapping.

5. Issues.

5.1 Updating Precipitation Frequency Atlases for the Entire Nation.

HDSC is currently updating the precipitation frequency atlases for a number of areas across the country and has been asked to expand the work to the entire country. Studies are underway for the Ohio River Basin and surrounding states, the Semiarid Southwest, Hawaii, and Puerto Rico and the Virgin Islands. Quarterly progress reports, which include schedules, for these studies are available at http://www.nws.noaa.gov/oh/hdsc.

Precipitation frequency studies are performed using funds provided by other federal, state and local agencies. HDSC is participating in an effort to assemble funds to update the precipitation frequency atlases for the entire United States. Hopefully sufficient funds can be identified to begin work during the summer of 2002. The full national update will use a consistent technical approach to data preparation, frequency analysis and mapping and as well as a consistent and more user-oriented approach to publication.

5.2 Depth-Area-Duration Study.

HDSC has agreed upon a major shift in the preparation of NOAA Atlas 14 (NA14). The preparation and presentation of depth-area-duration (DAD) values to be used in association with point precipitation frequency values will be done separately.

DAD values will be prepared for the entire United States. The DAD values will be presented in a stand-alone document separate from the one in which point precipitation frequency values are found.

The DAD study will be structured so that it can be completed in about one year from its inception. The main objective of the study is to determine whether the national DAD values presented in Technical Paper 40 (TP40), and reproduced in NOAA Atlas 2 (NA2), need to be revised for NA14. A dense rain gage network (DRN) scattered across the United States will provide precipitation information for a regional analysis. Procedures similar to those used to evaluate DAD in TP40 and NA2 will be used in this study for the sake of consistency.

If justifiable regional exceptions to the standard national DAD values emerge from the analysis of the DRN precipitation information, areas of applicability that are tied to a given DRN will be established.

6. Projected Schedule.

The following list provides a tentative schedule with completion dates. The schedule has been changed following a detailed examination of current status and to account for changes in technical approach and the addition of significant amounts of new data. However, we feel the changes that have been made were necessary and will significantly improve the quality of the study deliverables. Brief descriptions of tasks being worked on next are also included in this section. The University of Hawaii Digitizing completion date is indicated as Month Zero (M_0).

Data Collection and Quality Control [M_0 + 3 months]
L-Moment Analysis/Frequency Distribution [M_0 + 5 months]
Seasonal Analysis [M_0 + 5 months]
Temporal Distributions of Extreme Rainfall [M_0 + 8 months]
Implement review by peers [M_0 + 8 months]
Trend Analysis [M_0 + 9 months]
Spatial Interpolation [M_0 + 10 months]
Precipitation Frequency Maps [M_0 + 11 months]
Write hard copy of Final Report [M_0 + 12 months]
Publish hard copy of Final Report [M_0 + 14 months]

6.1 Data Collection and Quality Control.

A clear agreement has been established between the HDSC and the other funding agencies to wait for the University of Hawaii to manually digitize daily rainfall data from a network of state maintained rain gauges. The current estimation from the University is the data entry will take approximately one year to enter the entire dataset, causing a delay of the same length to the project while the HDSC waits for the data. The Big Island will be entered first and should be completed by the end of the Spring 2002 semester. The entry of the remaining islands will immediately follow. These delays are reflected in the above projected schedule.

6.2 Spatial Interpolation

The kickoff meeting between HDSC and Spatial Climate Analysis Service (SCAS) is tentatively scheduled for late January. This meeting will discuss the optimization of PRISM for spatial interpolation of rainfall frequency estimates for the Semiarid and Ohio Basin studies. PRISM will be applied to the Semiarid region during the next reporting period. The results of this effort will be later applied to the Hawaii study.

References

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U.S. Weather Bureau, 1962: Rainfall-Frequency Atlas of the Hawaiian Islands for Areas to 200 Square Miles, Durations to 24 Hours, and Return Periods from 1 to 100 Years, *Weather Bureau Technical Paper No. 43*, U.S. Weather Bureau. Washington, D.C., 60 pp.

Appendix A. Proposed Statement of Work

Production of Grids for the Semiarid Southwest and Ohio River Basin Using a Specifically Designed and Optimized PRISM System

Goal

The contractor, Spatial Climate Analysis Service (SCAS) at Oregon State University (OSU), will produce a series of grids for rainfall frequency estimation using an optimized system based on the Parameter-elevation Regressions on Independent Slopes Model (PRISM) and HDSC-calculated point estimates for the Semiarid Southwest and Ohio River Basin study domains. It is anticipated that successful progress on this task will lead to additional work of the same nature for the remainder of the United States including Puerto Rico and the Virgin Islands. However such additional work is not within the scope of this Statement of Work.

Approach

This contract will be a time and materials contract. Priorities will be maintained via close contact with a NWS representative, a status meeting, technical meeting and conference calls.

Background

HDSC will use the “Index Flood” approach as described by Hosking and Wallis in “Regional Frequency Analysis; An Approach Based on L-Moments”, 1997, to estimate rainfall frequencies. In this approach, the mean of the underlying rainfall frequency distribution is estimated at point locations with a sufficient history of observations. This mean is referred to as the “Index Flood” because early applications of the method were to flood data in hydrology. The form of the distribution and the other parameters of the distribution are estimated regionally. Once the form of the distribution has been selected and its parameters have been estimated, rainfall frequency estimates can be computed. The grids that are the subject of this Statement of Work are spatially interpolated grids of the point estimates of the Index Flood. The point estimates of the Index Flood are provided by HDSC. HDSC will select an appropriate rainfall frequency distribution along with regionally estimated parameters and will use this information with the grids of the Index Flood to compute rainfall estimates.

Scope of work

The contractor will address each of the following elements. It is understood that these elements do not necessarily occur in this order, nor do they occur just once. The proposed process is dynamic and has feedbacks. For purposes of establishing an optimized PRISM modeling system, the most widely used and familiar rainfall durations of 1-hour and 24-hour will be used. This does not preclude brief spatial investigation into different durations however. All other statistics will be produced during the production phase.

Adapt PRISM system

SCAS will use the present PRISM system, with some small modifications, to satisfy the need of the project. This includes a brief investigation into the pros and cons of using mean annual precipitation as a predictor for all durations. In order for the expected results to be properly evaluated, interim draft grids (or portions thereof) of all season 1-hour and 24-hour durations for each study area will be provided to HDSC.

Create draft maps and documentation for review

Draft grids for 1-hour and 24-hour durations will be produced. The ASCII grids will be made available to HDSC for evaluation, in addition to a brief report describing the methods used. HDSC will provide SCAS with a response, which will declare the grids ready for use in a formal, multi-agency review of 2-yr 24-hr and 100-yr 24-hr rainfall frequency estimates. The review process will be coordinated and undertaken by HDSC. Specific comments will be sought, and submissions of additional station data will be encouraged, plus the identification of questionable data and spatial patterns.

Modify data and model

An assembled and distilled list of appropriately justified changes/reviews will be presented to SCAS, and the HDSC-authorized changes will be incorporated into the system by SCAS. If this means the addition of data, HDSC will provide SCAS with that. To make certain the changes have resulted in the desirable output, an abbreviated pass through elements 2-3 will be needed to establish the final system. Changes to the system made by SCAS will be of limited magnitude, in keeping with the limited scope of this project (see Future Tasks for details).

Establishment of final process

The revised grids (1-hour and 24-hour durations only) will be delivered to HDSC for a limited, second review. As with the first review, HDSC will be responsible for carrying out this review, but SCAS may be requested to implement appropriately justified changes authorized by HDSC.

Perform Spatial QC

Using the optimized PRISM system along with a modified QC version of PRISM, a series of spatial QC tests will be conducted by SCAS. This will include the identification of statistical thresholds for questionable data, as well as evaluation of PRISM error statistics. Questionable point data will be passed to and resolved by HDSC. Recognizing that the data being provided by HDSC has already undergone extensive QC, SCAS will conduct cursory spatial QC for all grids.

Map production

After implementing the changes from the second review and conducting the spatial QC process SCAS and HDSC will have established an optimized PRISM modeling system for rainfall frequency. Using this system, all of the grids identified in Table 1 will be created. All of the point data will be provided by HDSC in the standard ASCII PRISM format.

Consistency checks and resample

Before delivering the final grids to HDSC, they must be checked for internal consistency by SCAS. In other words, the value of the Index Flood at each grid point for each duration must be less than/or equal to the value for lower durations at the same grid point. If an error of this nature occurs, the current convention is to set them equal, but before adopting this please consult HDSC.

Although the raw output grids from PRISM are at a resolution of 2.5 minutes, the final rainfall frequency grids shall be resampled to 30-seconds, minimally smoothed to remove extraneous noise and have units of mm*100.

Meetings

a. Kick-off meeting – Silver Spring (2-day)

A kick-off meeting between two SCAS representatives and the HDSC staff will occur at the start of the project. The purpose of the meeting will be to efficiently provide an adequate level of understanding about rainfall frequency to SCAS. This will entail providing SCAS with hardcopy maps of previous rainfall frequency studies, rules-of-thumb used by HDSC hand-analysts and share thoughts/concerns about the Semiarid project (e.g. understand differences between HDSC and PRISM maps). Furthermore, the meeting will provide the vital foundation of communication between HDSC and SCAS.

b. Status meeting – Conference call

At the initial conclusion of Element 3 for each study, a conference call/meeting will be held between HDSC and SCAS to discuss the draft maps and results thus far. At a minimum the following items will be addressed and/or available during the call:

Overview of progress
Representative draft hardcopy maps of rainfall frequency estimates illustrating the progress
Problems and successes
Priorities
Looking ahead

c. Technical meeting – Corvallis (3 days)

After the first review comments have been received, compiled and endorsed by HDSC, an HDSC-appointed liaison will travel to SCAS to aid in their incorporation into the PRISM process. The trip will be technically focused to fully resolving/incorporating all of the review comments (internal and external), addition of extra data, evaluation of spatial QC procedures and any other issues that arise. The result will be modified draft grids for the second (and final) review.

Deliverables

a. Reports

- A brief monthly status report will be submitted 5 working days after the conclusion of each calendar month describing (for the preceding month); activities performed, progress to date, problems or concerns, solutions for those problems, and anticipated work for the upcoming month.

- A brief report describing the methods used in modeling and quality controlling the rainfall frequency grids will be completed before the status meeting/conference-call. The purpose of this report will be for informing HDSC, reviewers and others of the progress through Element 2. A digital version of this report will be delivered to HDSC via e-mail.

- A final report incorporating the information presented in the interim reports will be delivered to HDSC following completion of the work.

b. Interim draft grids

Interim draft grids will be required on an as needed basis throughout the project. These will not be a required deliverable at the end of the project.

c. Final grids

Final Index Flood grids listed in Table 1 in an ArcInfo ASCII format. Metadata for the grids will be complied by HDSC. All digital data will be delivered via ftp.

Table 1. Index Flood grid list.

Duration	Season
1-hr	all
1-hr	cool, warm
2-hr	all
3-hr	all
6-hr	all
6-hr	cool, warm
12-hr	all
24-hr	all
24-hr	cool, warm
48-hr	all
4-day	all
7-day	all
10-day	all
20-day	all
30-day	all
45-day	all
60-day	all

Total (for each study area) : 26 (14 all, 6 warm, 6 cool)

Period of Performance

The duration of the project will be 1 year from the actual start date of the project. The following tasks and their associated durations are considered sequential for the purpose of establishing a schedule and period of performance. Certain tasks are dependent on timely delivery of materials by the Government. It is anticipated that the work for the two study areas will be done sequentially but staggered: draft coverages for the Southwest US will be submitted for review; while they are in review, the draft Ohio Valley coverages will be completed. Otherwise, milestones will remain the same.

Adapt PRISM/create 1st draft grids	8 weeks
Spatial QC	1 week

1st review	12 weeks
Adapt PRISM/create 2nd draft grids	8 weeks
Spatial QC	1 week
2nd review	4 weeks
Adapt PRISM/final map production	2-weeks
Consistency checks and resample	2-weeks

Future Tasks

HDSC is currently working on updates to the rainfall frequency atlases for Hawaii and Puerto Rico including the U.S. Virgin Islands. Furthermore it is likely (depending on funding) that a new study will be begun to update the atlases for the entire United States. If the national update is conducted, HDSC plans to enter into a follow up contract with SCAS to look for possible improvements in PRISM and its application to rainfall frequency and to apply PRISM in the national update. It is recognized that the modifications to the modeling approach may change the results for the Semiarid Southwest and Ohio River Basin described here. In general, those changes will be small, we believe. However if they are significant then they will be used to update these results.